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ABSTRACT

The present Topic Classification System (TCS) developed out of a 7-year period of research and supplements an earlier system (Aschner, Gallagher, 1965). The purpose of the system is to indicate 1) level of conceptualization (data, concept, or generalization); 2) the style of thinking (activity, description, explanation, evaluation-justification, evaluation-matching, or expansion); and 3) the emphasis of the instructor on skill or content in classroom discussion. A study was conducted to use the TSC to compare teacher instructional strategy when variables of subject matter, teacher background, student ability, and concept to be taught are held constant. Subjects were six biology teachers and their high ability students using the Biological Science Curriculum Study (BSCS). Discussion sessions of each class were recorded for three consecutive days while the teacher was introducing the subject of photosynthesis. Each script was divided and classified by two staff members independently. Significant differences were found between teachers in gcals and levels dimensions but not in style. Teachers talked most, but with substantial differences between teachers in terms of amount of student talk allowed. Those students showing greatest degree of verbal expression (more boys than girls) also showed greater proficiency according to grades and tests. The TCS was a useful analytic system for describing teacher-student interaction and comparison of various instructional patterns. (Implications for research and teacher training are discussed.) (JS)

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A Model for Studying Teacher Instructional Strategies

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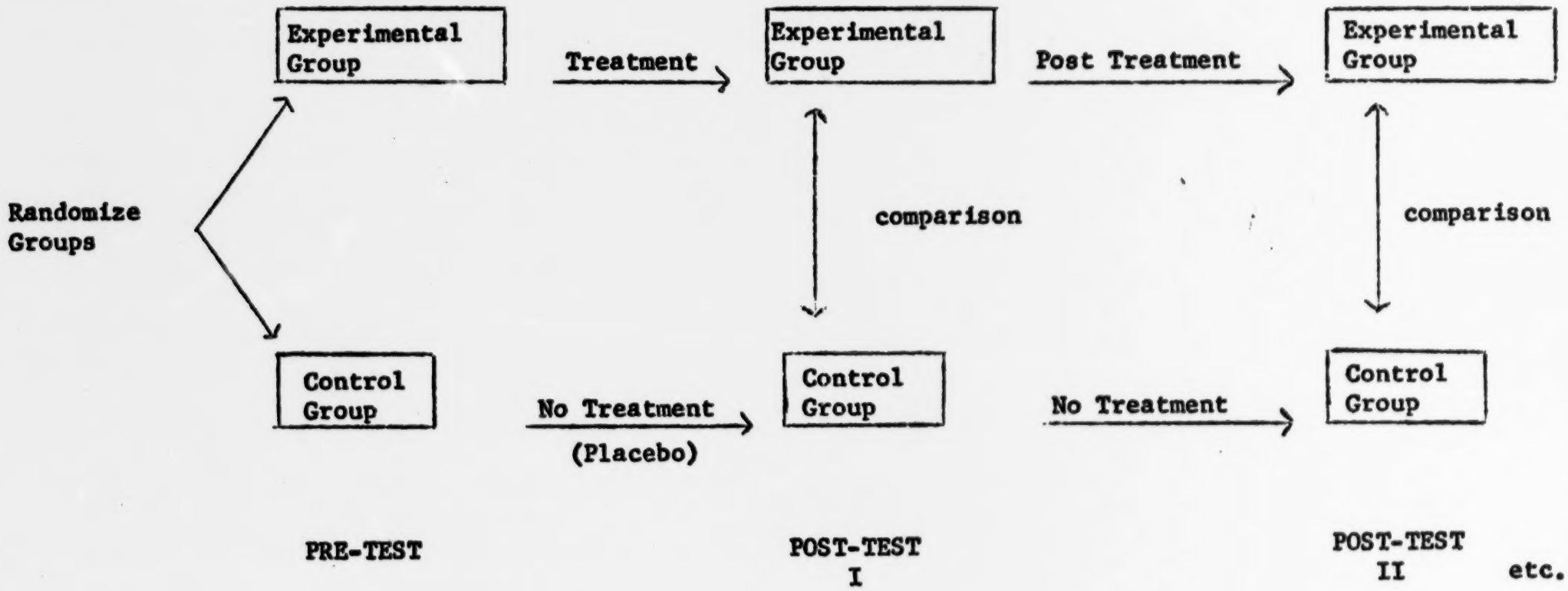
Is teaching an art? Indeed, it is. Perhaps too much of one. Surgery was once too much an art and many people died as a result. Cooking is an art, and while few people die of it these days, drugstores do a thriving business in remedies for misbegotten creative culinary efforts. For when a set of skills is in a developmental stage where people say, "It is an art," they mean several things. First, that there are only a very few persons who have the skills that can identify them as highly effective practitioners, as 'artists.' Second, even these 'artists' cannot give a systematic account of how they practice their 'art,' and they are reduced to modeling their performance for those who would learn from them. But it is hard to imitate the true artist, and his genius too often dies with him.

Those interested in the improvement of education and teaching would like to remove some of the mystery of the art of effective teaching through systematic study. Earlier attempts to study educational programs adopted a type of research design that had worn well in the biological-medical setting. Figure 1 shows such a design. It is easily recognized as the way to test a new drug or cold vaccine. Two groups are selected randomly from a population to protect against sample bias, and while one group (Experimental) gets the vaccine, the other (Control) is given a placebo or pink pill to guard against recovery due to suggestion. Extensive tests are given at the posttest period to determine if the new medicine was more effective than the placebo.

Figure 1

TRADITIONAL EDUCATIONAL EVALUATION MODEL



It is easy to conceive of an analogous educational study attempting to evaluate the 'new math' program. The sample is randomized, extensive tests are given to both groups before the program is instituted, and periodically after the program has been in progress. The control group continues to receive the standard program while the experimental group is immersed in the new one. While there can be a superficial analogy between the medical and educational situations, there are some good reasons why this model has little payoff for the educator who wishes to know how to improve educational programs.

The difference lies in the nature of the treatment variable. In the medical experiment there is great care taken to insure uniformity of treatment. One dose of vaccine is identical to another. But in education who can say that the 'new math' taught by Mr. Cone is the same as the 'new math' taught by Miss Ascreme? Wide treatment variation can thus be expected in the educational experiment. Even worse, can we describe the treatment at all? For the treatment turns out to be a fantastically complex set of socio-psycho-educational variables.

Psychologists have their black box in the human mind where they see stimuli go in and responses come out but can only speculate what actions and processes have occurred in between. The educator has his black box also, the classroom! Extensive investigations have been executed studying the variables going into the black box in terms of teacher characteristics, student ability and personality. Similar research has been devoted to analyzing the outcome variables of achievement and performance, all the while speculating what might be going on inside that black box, with little concrete results. For example, a review of the literature on

teacher personality (Getzels and Jackson, 1963) yielded the following conclusion:

> Despite the critical importance of the problem and a half century of prodigious research effort, very little is known for certain about the nature and measurement of teacher personality or about the relation between teacher personality and teaching effectiveness. (p. 574)

But the educator is fortunately in a better position than the psychologist to open his black box and look inside. What he needs is a technology that will allow him to reproduce the teaching process, and he has that in audio and video tapes. He needs also some model or system by which to organize the myriad of behaviors in the classroom so that something of instructional value and theoretical significance can be deduced.

In the last decade, many different investigators took many different approaches to the classroom investigation. Among the most important were: Aschner, Gallagher, et al (1965); Bellak, Davitz, et al (1963); Flanders (1965); Hughes (1959); Perkins (1964); Spaulding (1963); Taba, Levine and Elzey (1964), etc.

The Topic Classification System

The present classification system developed out of a seven-year period of research and supplements an earlier system (Aschner, Gallagher, et al, 1965). Both of these systems owe much of their conceptualizations to the theoretical work of Guilford (1956, 1959) and his evolving structure of the intellect. The operations dimension of his model can be seen in both the present and previous models although sizable modifications have been made from the original Guilford projection. The purpose of this system of topic

classification is to indicate the level of conceptualization, the style of thinking and the emphasis of the instructor on skills or content in classroom discussion. Figure 2 gives a schematic picture of the three dimensions in this system which allows the investigator to analyze sub-units called topics in terms of instructionally relevant variables.

Each investigator in the field of classroom interaction has felt the need to establish some units for the purposes of analysis. In this system the term topic is used to delineate a unit where the focus of classroom discussion centers on a given action, concept or principle. Classroom discussions do not necessarily follow orderly sequences. Therefore, the length of time spent on a subject under discussion determines its status as a topic. A more thorough description of the topic, its divisions and classifications, are given in Gallagher, Shaffer, et al (1966).

In a given one-hour class session, one normally expects to find between 15 and 25 Topics. These, in turn, can be grouped under larger headings entitled Themes. A Theme is a unifying element for a group of related topics which represents a larger idea encompassing a series of topics. One would generally expect to find one to four themes for one hour's script.

Content-Skills

This dichotomous dimension refers to distinctly different teaching goals. Content refers to the goal of injecting a given body of knowledge into the student. Information, ideas, or concepts are presented to the student and he is expected to absorb them.

The second area, Skills, refers to the goal of teaching the student a set of behaviors or skills which will enable him to master successfully situations that he will meet in the future. Such activities as instruction in reading skills, learning grammatical rules, mastering mathematical operations, are referred to as Skills. Included also are the broader concepts of learning the methods of scientific investigation, learning how to design and execute an experiment, how to handle data, etc.

Level of Conceptualization

One weakness of previously constructed classification systems has been their lack of consideration for the level of conceptualization. In a curriculum where the importance of an idea is judged crucial, a classification system should indicate whether or not the class is generally operating on a high or low abstract level. The three levels utilized in the present system are crude and a deliberately limited view of a more infinitely complex abstractional ladder. Data represents the discussion of specifics, the individual event or instance, the personal anecdote, the concrete level of happenings. Concept represents a certain degree of abstraction of data to general ideas and their applications or associations. Generalization represents the larger ideas or concepts in relationship to one another as found in a scientific law or the general principles of economics or history.

Style

This dimension deals with the style of thinking evident in the discussion held in the classroom. It focuses on how information is being processed, the focus of a topic in a class session can be on Description,

or the defining or describing of aspects of a concept or event; on Expansion, which would lead the group off to other lines of thinking or encourage new associations; on Explanation, which would focus on reasoned argument through sequential deductive steps of thinking; or Evaluation-Justification, which reveals an attempt to make a decision and then explain the reasons for the judgment; or Evaluation-Matching, which depends upon the presence of previously established criteria for judgment and attempts to match events or circumstances to those criteria. Activity refers to student work in the classroom other than discussion. This can be doing math exercises, an experiment, role playing, correcting grammar in written sentences, etc.

In applying the classification system to the scripts in the present study, a procedure was followed that had been found workable in a previous research project (Gallagher, 1965). Two judges would independently rate each script, first making topic divisions and then classifying. This is done by seeking the topic focus or central idea of the passage. Naming the topic often helps in fixing the focus, and when the focus changes, a new topic has begun. These judges then would consense their decisions on classification. If any decisions remained unresolved as a result of this consensus meeting, they were brought before the total staff for discussion and sometimes used for modification or extension of established rules.

It was found necessary to consistently use two judges since it was difficult to keep a firm frame of reference on the entire system, and consensus helped iron out tendencies to overlook a category or overemphasize a category during a classification session. Reliability in this case is not determined by a comparison of the two individual judges but rather between two teams of judges operating in this fashion.

Figure 2

TOPIC CLASSIFICATION DIMENSIONS--CLASSROOM INTERACTION ANALYSIS

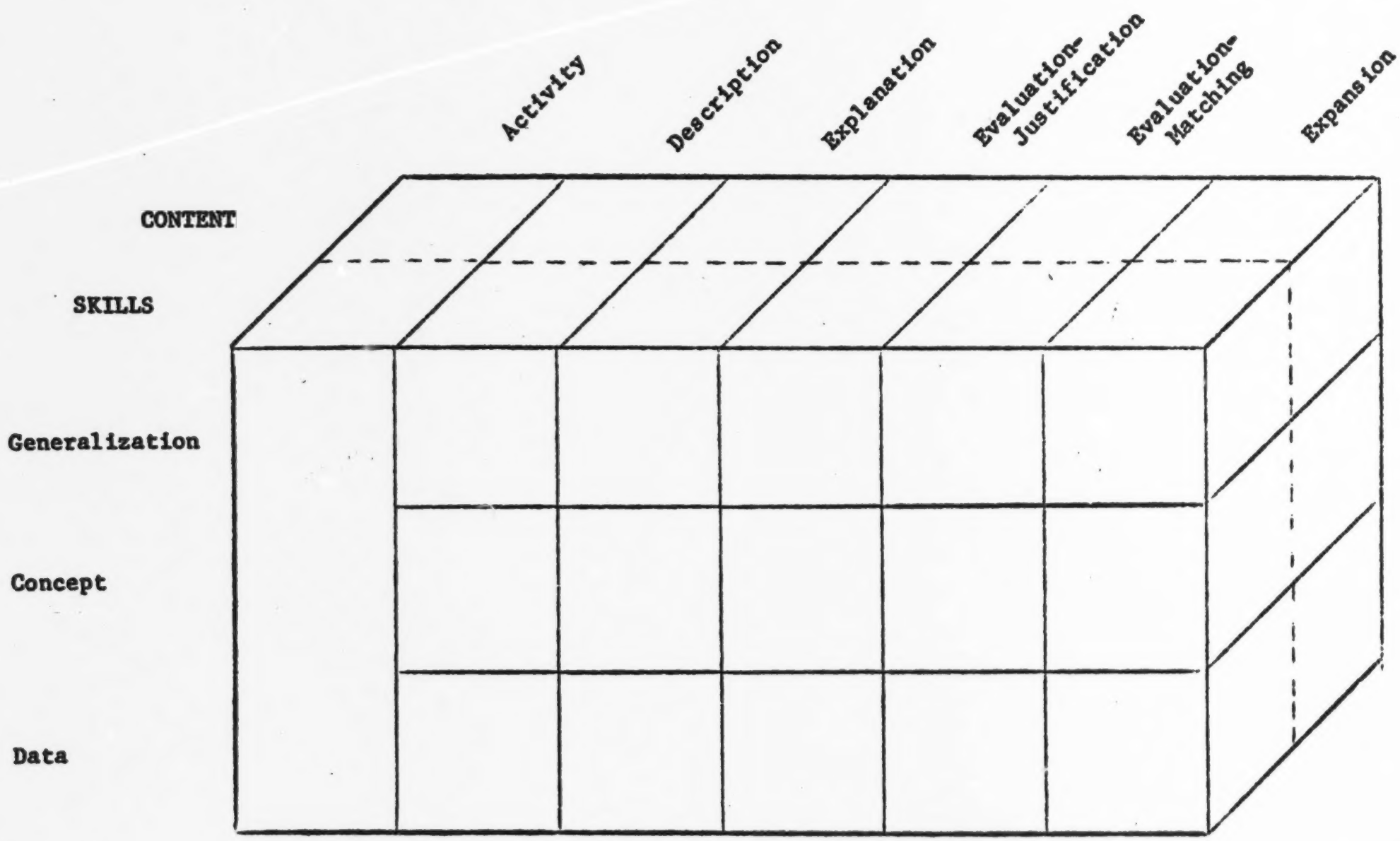


Figure 2 portrays the three dimensional classification system. A topic can be classified in each of the three dimensions. Thus, a topic whose focus would be on the definition of an autotroph would be CONTENT-CONCEPT-DESCRIPTION. A topic whose focus would be on how to record data stemming from a class laboratory experiment would be SKILLS-DATA-EXPLANATION, and so forth.

Table 1 gives some examples of topics that would fall into various cells of the present classification system. By following the columns up in Table 1, the reader can grasp the change in abstraction level. By following the rows across, one can see the change in style and emphasis. The Content vs. Skills dimension is not included in this table. Two examples of this distinction would be:

Skills - The description of a microscope and how it is to be used in collecting observations.

Content - The discussion of the history of the microscope and its invention.

Skills - The learning of rules for sonnet construction preparatory to writing a sonnet as a class project.

Content - Learning the rules of sonnet construction without explicit student application or personal use.

Table 1

TOPIC CLASSIFICATION OF BIOLOGICAL CONCEPTS

	DESCRIPTION (D)	EXPANSION (E)	EXPLANATION (X)	EVALUATION (V)
GENERALIZATION	The system of photosynthesis.	What would happen if the system of photosynthesis ceased functioning?	Show how the system of photosynthesis explains the change in leaves from brown to green.	Does this represent an adequate statement for photosynthesis? $CO_2 + H_2O \longrightarrow [CH_2O] + O_2$
CONCEPT	The definition of a heterotroph.	Contrast the autotroph and the heterotroph.	How do we know that the oxygen from photosynthesis comes from water?	Do you believe it was essential that autotrophs developed?
DATA	What colors do you see in the spectroscope? Record them.	Comparing the black vs. white cloths their ability to absorb light.	Describe in sequence the experiment by Calvin.	Was <u>our</u> experiment a success?

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Procedure

Statement of the Problem

The purpose of the present study was to use the topic classification system to compare teacher instructional strategies when variables of subject matter, teacher background, student ability and concept to be taught are held constant.

Previous attempts to observe instructional content and style have often been defeated by the large number of variables that might influence classroom performance. It was the intent of this study to have the major portion of the variations due to teacher instructional strategies.

Subjects

The subjects in this study were six biology teachers and their high ability students who were studying the Biological Sciences Curriculum Study (BSCS) Blue Version Molecules to Man. All of the teachers were instructing the classes in suburban communities outside of a metropolitan area and all had had some previous training contact with the BSCS program. All teachers who were contacted agreed to participate in the study.

The students were selected for these classes on the basis of high ability and/or high achievement. The aptitude scores for five of the six class groups were obtained and transformed into standard scores. The sixth school maintained a policy of not releasing aptitude scores and thus, these were unavailable. The five groups showed the general characteristics expected of honors classes with mean aptitude scores falling between +1 and +2 standard deviations above the mean for both boys and girls.

Curriculum Content

The Biological Sciences Curriculum Study, organized in 1959 by the education committee of the American Institute of Biological Sciences, represents one of a number of reform movements in curriculum development for the schools (Schwab, 1963). By the middle 1950's, many physical scientists and mathematicians had become increasingly disturbed regarding the content of the material presented in their speciality at the secondary school level. Whatever the field of speciality, a review of existing textbooks showed that attempts to squeeze new information into traditional texts had only created a weird patchwork quilt from which the most brilliant student or the most capable teacher was hard put to extract important generalizations. (See Bruner, 1960).

Groups of scholars in the various disciplines took it upon themselves, often in cooperation with educational personnel, to design and construct new sets of curriculum materials that would reflect more adequately the status and intent of the sciences. These ventures, supported, in large part, by financing from the National Science Foundation, have played a highly significant role in secondary education during the past decade. (See Goodlad, 1964).

This group, like others of similar nature such as the Physical Science Study Committee, the School Mathematics Study Group, the Chemical Bond Approach, etc. had as major goals:

1. The presentation of a structure of important interlocking ideas and concepts that lie at the heart of their discipline. They were willing to sacrifice breadth of coverage

of an area so that the students could grasp this essential structure.

2. They were committed to the idea that one of the best ways for a student to understand science was to act like a scientist. Therefore, he should play an active role in the conducting of experiments and in performing in the scientist's role as much as was feasible.

Three major versions of the BSCS curriculum effort have been published. The 'blue' version, that presents a systematic portrait of 'Molecules to Man,' is the version that was used in all classrooms in the present experiment.

While the BSCS has attempted more large-scale evaluation (See Grobman, 1962) than most of the other projects, the very nature of comparing hundreds of classes and thousands of students tends to obscure factors internal to the classroom that are potentially related to achievement.

Method

The selection of the concept photosynthesis to be used as the focus of the recordings was made in consultation with the BSCS staff at Boulder, Colorado, who felt that this concept would give maximum latitude for the development of important ideas and generalizations. The Blue Version of BSCS was chosen in preference to the Green or Yellow versions on the basis of geographic availability of classrooms to the investigator.

Arrangements were made to record each of the classes in their discussion sections for three consecutive days while the teacher was introducing the subject of photosynthesis. In each instance, the instructor

informed the investigators as to what date they would begin the discussion of this concept. The arrangements were then made to record on that date. It is interesting to note, in passing, that there was a range of about a month-and-one-half as to when each of the instructors reached this point in their year's sequence.

The technical arrangements were the same in each of the recorded sessions. Three directional microphones were used and the resultant sound was placed into a mixer thence into an Ampro tape recorder. At least one of the staff members of the project and sometimes two were present during the recording and helped arrange and balance the sound. One day of practice was used in order to establish appropriate sound levels and also to acclimate the students to the presence of the equipment before actual recordings were taken.

The observer in the classroom had a seating chart available to him identifying the students and attempted to take continuous notes, identifying the speaker wherever possible. The translation of the recording into a final tapescript for analysis followed this procedure. The observer who was present in the classroom would listen to the tape recording and then dictate into a dictaphone what he heard on the tape and recalled from his notes. This was found to be most preferable to a secretary attempting to take the information directly off of the tape since the specialized vocabulary and the general difficulties of comprehending softly spoken voices made direct secretarial transcription too difficult. This dictated rough draft was then edited and corrected by the observer and one other member of the staff and a final tapescript was thus produced.

Each script was then divided and classified by two staff members independently. They then met and consensed their judgments. Often this meant pointing out to the judges that they had overlooked some category criterion. When differences remained, the script was brought before the six staff members of the project and a resolution obtained. These scores were then used as the bases for further analysis.

Analysis

While much of the information collected was of a descriptive nature, inter-classroom comparisons were made wherever possible. Since discrete categories were involved, non parametric methods were used to test for differences.

Results

Topic Classification System

Table 2 presents a summary of the percentage of topics occurring in each dimension of the Topic Classification System for each classroom. The total number of topics for the three days of recordings ranged from 45 to 61, or about an average of from 15 to 20 topics per class session. Since there were variations in the length of class period, the key data here are presented in the form of percentages.

In the first dimension of the system, Goals, there was a substantial difference between teachers in terms of their overall instructional strategy. Students played a very minor role in determining classroom activities or initiating topics. The percentage of Skills topics ranged from zero in

YANCY and ZORBA to about 30% of the total in VIRGIL and WILLIE. The majority of the Skills topics found in the present study were focused at the Data and Concept level of abstraction. They ranged from the specific of 'How to work with this tube of chlorophyll' to 'How to obtain a pH value with indicator dyes' to the more general topics focusing on 'The value of using chromotography in collecting data' and 'The use of constants in scientific formulae.'

The purpose of the Skills topics seemed to be on the development of greater student aptitude to act in the role of a scientist and appeared to be directly related to one of the major goals of the BSCS program, teaching science as inquiry. Despite this common goal, there was significant variation between the six classes in terms of the frequency with which these matters were focused on in class discussion.

This does not mean necessarily that those teachers not showing any Skills topics in this analysis did not pay attention to this goal. It is quite feasible that in laboratory sessions or in discussions with individual students these topics did receive attention.

In terms of the Level of Conceptualization, Table 2 again shows substantial differences in the percentage of topics used in the current class sessions. At the highest level, Generalization, which demanded a focus on a large idea with broad application or a discussion of an abstract system, the range of percentage of total topics was from 2 to 16%. In those classes receiving the higher percentages, there were discussions on the interrelated parts of the photosynthesis process, discussions of glucose conversion to starch and several generalizations on the nature of light.

An interesting pattern was revealed in YANCY where 95% of all topics were found to be at the Concept level with little Data or Generalization being focused upon. There is reason to believe that the Generalization level is hard to attain without a substantial amount of concrete data present in the students' perception or memory bank. VIRGIL and WILLIE both showed an affinity for discussions focusing on specifics (27 and 32 % Data topics) which corresponds to the presence of Skills topics in their classes. A Chi Square test on the proportions involved under Level of Abstraction indicated a highly significant difference between teachers on this dimension.

In the third general dimension of the classification system, Style, there was a fairly common pattern revealed across all six teachers, with a great emphasis on topics in the areas of Description and Explanation. From 71 to 85 % of the topics fall in those classifications in the present sample. There were few topics which dealt with Evaluation or decision making of any sort. The greatest variation in Style categories was found in the Expansion dimension, with URIAH showing 22% of the topics in this dimension, while YANCY revealed a low of 8%.

One can note also that the Evaluation-Matching category was hardly used at all. This means that judgments made on the basis of a matching of instances or data to an established criterion or criteria was one type of topic that rarely was seen in these classes. The high percentage of Expansion topics in URIAH was due to some degree to his extensive use of graphs in class discussion. The translation of data from one medium to another, from figural to verbal, was one major criteria for the Expansion category. A comparison and contrasting of two or more ideas also increased the Expansion topic count in that instance. A Chi Square test of the

Table 2

PERCENT OF TOPICS IN EACH DIMENSION OF CLASSIFICATION SYSTEM

		GOALS		LEVEL			STYLE				
Class	Total Topics	Content	Skills	Data	Concept	General.	Descr.	Explan.	Eval-J.	Eval-M.	Expans.
URIAH	55	96	4	7	91	2	31	40	7	0	22
VIRGIL	45	71	29	27	68	6	33	48	9	0	9
WILLIE	61	70	30	32	64	4	48	38	4	0	11
XAVIER	48	85	15	26	58	16	44	37	2	0	17
YANCY	60	100	0	3	95	2	39	46	7	0	8
ZORBA	57	100	0	11	80	9	38	47	2	2	11

$X^2 = 48.84$ $X^2 = 34.77$ $X^2 = 14.98$

df = 5 df = 10 df = 15

p = <.01 p = <.01 p = .50

difference between teachers failed to reveal significant difference in Style and suggested that the patterns shown by these six teachers were consistent with one another with the emphasis in all resting strongly on the dimensions of Description and Explanation.

Overall, there were significant differences between teachers found in two of the three major dimensions of the Topic Classification System. In Goals and Levels, there were sufficient teacher variations to suggest that the individual teacher was having a substantial impact on how the biological concepts will be presented in class discussion in these dimensions. Only in the Style dimension did the teachers seem to show some uniformity of pattern.

Teacher-Student Talk

One of the functions of class discussion is to allow the student the opportunity to clarify his limited understanding of new concepts and enrich his conceptual field in the topics considered crucial by the teacher or as introduced by the students. As Schwab stated:

> Discussion of a certain sort is indispensable for the development of the intellectual arts and skills required to traverse a pathway of understanding. (Schwab, 1963, p. 430)

In addition, discussion can serve as a stimulus to greater motivation on the part of the student and encourage some student modeling behavior of the teacher. Accordingly, an attempt was made in the current analysis to discover the degree of student participation in the current classes.

The number of lines spoken by each student and the teacher were counted as they appeared on the tapescript. Total student line scores were obtained and these were translated into percentages for the purposes of comparison.

Table 3 shows the percentage of total teacher talk by topic classification and by class group. This figure was obtained by taking the total number of counted lines in the tapescript and dividing the number of lines attributed to the teacher. In total, the range of percentage of teacher talk extends from 66% in URIAH to a 95% in XAVIER. In all classes, there seems to be a consistent tendency for the teacher to speak from three to four times as much as the students.

In classes such as XAVIER with 95% teacher talk, and ZORBA with 89% teacher talk, the character of the classroom seemed more of a lecture punctuated by questions asking for short answers on the part of the students. In classes such as URIAH and VIRGIL the total percentage suggests that there were discussions going on in class session with significant pieces of cognitive interchange from the students.

Two statistical analyses were done on the data in Table 3. The first question asked was whether there was significant difference between teachers in terms of the percentage of talk they do in topics of each Style classification. In all of the topics labeled Description, the percentage of teacher talk can be seen under this category for the six classes in Table 3. The range of teacher talk is from 97% in XAVIER to a low of 76% in URIAH. A Kruskal-Wallis, Non-Parametric Analysis of Variance, indicated that there was a significant difference between teachers in the amount of teacher talk per class in topics of this character. Similar levels of statistical significance were found in topics related to Explanation and Expansion. While there was a trend also on topics related to Evaluation, the results did not reach levels of accepted statistical significance. It seems quite clear on the basis of this and previous analyses that there were substantial

Table 3

PERCENTAGE OF TEACHER TALK BY TOPIC CLASSIFICATION

	STYLE CLASSIFICATION					
Classroom	Description	Explanation	Evaluation	Expansion	Total	H
URIAH	76	59	57	67	66	3.4
VIRGIL	78	73	60	72	72	1.4
WILLIE	81	83	91	87	83	4.7
XAVIER	97	91	100	100	95	---
YANCY	86	83	77	76	83	4.9
ZORBA	87	91	92	79	89	1.9
TOTAL	84	80	69	79	80	
H	14.24*	13.99*	7.77	11.55*		

*p < .05

differences in teacher style in terms of amount of student talk that takes place in the classroom and that these remain fairly consistent from one Style classification to the next.

A second analysis was done to see if the teachers show differences in their own style of response depending upon the kind of topic that was involved. The question asked was whether a teacher talked more in Description topics than in Explanation topics, or whether he encouraged more student participation in one type of topic than in another. Did the teacher change his style or strategy of approach depending upon the kind of topic that was being discussed? A Kruskal-Wallis Analysis of Variance was calculated, and in none of the sections was there a significant difference obtained. This lack of significance indicated that the teachers generally kept the same proportion of teacher-student talk regardless of the type of topic discussed. None of the teachers significantly changed their approach on the basis of the topic being discussed. In other words, they kept the same style throughout.

The overall portrait that is drawn here is that the teachers do the lion's share of the talking in discussion sections even to the point of almost complete lecture; there are substantial differences between teachers in terms of amount of student talk allowed in class sessions, and teachers remain internally consistent in amount of talk allowed regardless of the type of topic discussed in the Style dimension of the classification system.

Expressive vs. Nonexpressive Students

Another matter of concern to teachers revolved around the nature of the students who contribute substantially to class discussions. Are they

really the topnotch students adding to their conceptual network by their questions and contributions, or are they merely compulsive talkers who contribute to the discussion for a variety of social and motivational reasons only dimly related to scholarship? Another analysis done on the present samples of students was to compare a sample of the two extremes, the most and least expressive students. Expressiveness was defined as the amount of lines spoken in the final tapescripts. The top three boys and girls were chosen in each class on this basis. In one class the limited number of girls caused a choice of less than three.

The least expressive children were chosen by the same method. In some classes where there were more than three students who had zeros, which meant no verbal participation of any sort for the three days, the first three of these students were chosen for the nonexpressive sample on the basis of alphabetical order.

Table 4 shows the comparison of the most expressive versus least expressive students divided by sex. These groups were compared on measures of aptitude, performance on the BSCS test, a teacher-made test covering the unit in which the recorded material was included, and finally the teacher grade for the course.

On measures of aptitude the scores of the students were first transformed into standard scores in order to equate for the different tests used in the different school systems. This was done by transforming the scores into a mean of 100 and the standard deviation of 10. Thus, a score of 120 on aptitude z score represents a mean of 2 standard deviations above the average. On the measures of aptitude there was a difference found between expressive and non-expressive girls at the .05 level of

Table 4

EXPRESSIVE vs. NON-EXPRESSIVE STUDENTS

ON APTITUDE AND PERFORMANCE VARIABLES

BOYS

Variable	Expressive			Non-Expressive			t	p
	N	Mean	SD	N	Mean	SD		
Aptitude z Score	14	123.86	6.66	15	120.04	6.06	1.61	
BSCS Test	17	35.82	5.17	18	31.44	5.74	2.37	$< .01$
Teacher Test	17	3.29	.69	18	2.78	2.83	2.03	$< .05$
Teacher Grade	17	3.35	.86	18	2.83	.92	1.73	$< .05$

GIRLS

Variable	Expressive			Non-Expressive			t	p
	N	Mean	SD	N	Mean	SD		
Aptitude z Score	13	123.15	3.84	13	119.79	5.50	1.81	$< .05$
BSCS Test	15	34.53	4.69	17	31.24	6.95	1.58	
Teacher Test	16	3.12	1.02	17	2.53	1.23	1.51	
Teacher Grade	16	3.50	.82	17	2.82	1.24	1.88	$< .05$

significance and the results approached significance for the boys. As expected, the expressive students showed more ability or aptitude than the non-expressive ones.

The most interesting finding of the BSCS test, which represented written proficiency in the area of biology, was that there was a highly significant difference between expressive and non-expressive boys. There was also a difference in the same direction in favor of expressive girls which did not reach accepted levels of statistical significance. These results would seem to indicate that students who participate verbally in the class discussion were generally better students than those who did not participate. It is thus not a matter of students talking to hear themselves talk, but means that the students who are talking do seem to have a greater grasp of biological concepts as measured by the BSCS test than do those who remain silent.

On the teacher-made test, the grades obtained by the student were transformed into a four point scale with four representing an A, three a B, etc. On the teacher-made test, there was again a significant difference found between expressive and non-expressive boys in the predicted direction for the boys, and in the expected direction for the girls but short of statistical significance. As might be expected, the teacher grades parallel very closely the performance on the teacher test. Again, there were statistical significant differences in favor of the expressive students in both the boys and the girls.

These total results seem to support the notion that those students who showed the greatest degree of verbal expressiveness in class also show greater proficiency in the biological area as represented by teacher

grades, tests, and objective BSCS tests. It also implies that class discussions do provide a useful arena in which knowledgeable students can hone their imperfectly grasped concepts.

Other results presented in more detail in the original report (Gallagher, 1966) indicated that the actual content of the discussions varied in terms of concept emphasis and inclusiveness. The instructors selectively chose from the available material those ideas they believed to have the most relevance for themselves and their classes. Variation between instructors was also found on the tendency to bring in ideas or concepts from outside the unit that might have some bearing on it.

Also found was a tendency for boys to be significantly more expressive in class than girls. When this result is juxtaposed with the finding of no differences in actual achievement measures, a social-sex role basis for the difference in classroom expressiveness was held. There was the additional implication that some other mode needs to be found for girls to express themselves and gain feedback for their own ideas than the public arena of large classroom discussions which are apparently inhibiting to them.

Discussion

The results of the present study indicated that the Topic Classification System was a useful analytic system for describing teacher-student interaction and comparing various instructional patterns given the same subject matter and concepts to be taught. Analytic models such as the one used in the present study provided the basis for objective reporting of both content and style dimensions of instruction.

Most of the new curriculum projects have embarked on some evaluative efforts in this direction and more demands for systematic evaluation are sure to come as the increasing costs of such programs require justification. One type of evaluation has been to compare old and new curriculum across as many classes as one can control, and this sometimes can involve thousands of students. This investigator does not believe that such massive comparisons yield much information to the persons struggling to improve their curriculum programs. There are too many variables interacting in the macrocosm of these many classrooms and different communities to allow for precise analysis.

Instead, the answer would seem to lie in clear delineation of the microcosm of the individual classroom observing as precise and limited goals as possible. In this way, it is possible to see how different teachers present certain concepts and to test students on their understanding or ability to apply that particular concept. To establish the understanding of a system such as photosynthesis there should be some irreducible number of concepts that have to be introduced and interrelated. There may be more payoff in the intensive study of one brilliant student and his response to instructional strategies from one point in time to another than the global analysis of a thousand students over the course of a year.

Another potentially useful research strategy is to use the teacher as his own control and establish a baseline of instructional strategies for that particular teacher. This study pointed out that each teacher does have his own baseline for the amount of student participation, for example. Systematic instruction could then be given to the teacher on how to develop Expansion topics, for example, and then measure the change in class performance and knowledge.

The ability to record and preserve teacher performance has opened up a wide vista of opportunities for the intensive study of instructional strategies and their immediate effect on students. They offer the opportunity for curriculum innovators to also record influence, over a short and reasonably controlled period of time, of their own interventions through the use of analytic models described in this study and in others in this publication.

Training

As important as the research possibilities is the potential usefulness of this approach to the training dimension. In the absence of specific instruction and self analysis, most teachers teach as they were taught. It is an intuitive and rarely thought through skill. Occasionally, this intuitive approach yields an outstanding instructor. Just as occasionally a pharmacist mate or a nurse is a better practitioner of medicine than the doctor, but professions do not rely on such chance happenings.

One substantial trend in teacher education has been in the direction of careful self analysis of one's own performance through study of videotapes or recordings using such tools as the Topic Classification System presented in this study. In this way, they can plan the kind of topics they wish to teach, the style in which they wish to present them and the level of abstraction at which they expect the work to occur.

A reexamination of their teaching, through analysis of their own performance, provides the medium through which instructional strategies can be effectively modified and through which such goals as increasing student inquiries can be systematically attained. It is in this dimension

that one can increase teacher self awareness and allow the teachers to set their own goals without necessarily inducing a mindless conformity or uniformity of instruction.

Most of the new curriculum movements have been impressed in their first contacts with content area teachers as to how deficient these teachers were in basic understanding of their subject area. Much of the emphases of the training programs were therefore centered on learning the 'new math' or the 'new biology' or what have you. Other instructional goals such as teaching for inquiry or stimulating creative abilities of students were given second place and presented, if at all, through the observation of a master teacher at work.

If the data of the present study are to be believed, such limited emphases on instructional strategy are not enough. Several of the present groups showed little in their discussion sections that resembled a substantial interchange of intellectual ideas between student and teacher. In some, the emphasis on inquiry or searching was not carried from the laboratory to the discussion period. To obtain the goal of a vibrant discussion period, most teachers must be taught the cognitive skills of how precisely to conduct a class discussion, or how to stimulate innovative approaches on the part of the student. Such teaching of instructional strategies has to be as explicit as the subject area teaching, if one wishes the teachers to have similar competencies.

One area of greater emphasis might be placed upon instructional strategies on distinguishing between what can be expected from the public environment of the usual class discussion and what goals might be better obtained in the more private environment of teacher-student conversations,

or the private exchange of written work by the student and the constructive response of the instructor. The present study revealed that girls tended to not participate in the public arena as much as the boys though achievement measures indicated that they were the equal of the boys in this regard. It is possible that effective communication with girls has to be done through the more private dimensions where the social aspects of the situation do not inhibit their performance.

In this study, there was no question but that those students who were constant participants in class discussion were superior students to those who did not participate. They were not merely talking to hear themselves talk. They did reveal that they had an informational fund and the thinking ability to hold meaningful interchanges with the instructor. At the same time, there was a substantial number of students in every class who were mute, or nearly so, in the three days of discussion. What lines of communication can be set up between the teacher and these students that can aid in their improving their comprehension of concepts and generalizations?

The results of this study have confirmed again that diversity is the central fact of human existence. In this case, the diversity of six competent teachers is their method of presenting the same curriculum materials. Such diversity may or may not have substantial influence on students, but it would be surprising indeed if it did not. It would seem to suggest that those interested in curriculum development have not finished their job when they have packaged a cognitively valid and consistent set of materials. They must establish, in addition, how these materials are operationally introduced in the classroom environment. Otherwise, they will be left with certain unjustified assumptions as to how their package is unwrapped in the classroom.

If the use of classroom interaction analytic models can help educators move from exhortation to objective instructional analysis, they have been of great value. Actually, the potential for these currently crude instruments is much greater in both the research and training dimensions. Their eventual utility, as in the case of all tools, will be determined by the imagination and creativity of those who use them.

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